



Plastics Discovery Tour 2023

# Compostable Bioplastics: Italy Sets the Standard

Synergistically combining know-how and skills, a group of Italian companies has developed three automated injection molding lines for the production of single-use compostable cutlery: a solution that optimizes productivity, quality and costs.



Armido Marana (left) and Antonio Munarini of Ecozema in front of the Engel e-mac 280 for the production of single-use cutlery in compostable bioplastics. © Ecozema

**B**ioplastics is a market destined to grow, reaching a global capacity of 6.3 million t by 2027, the association European Bioplastics expects. Consumption should follow at the same pace, driven by changing consumer environmental awareness and regulations that will come into force in the future. Italy already stands out as a bioeconomy case study. Considering a total of 320,000 t of bioplastics processed in Europe in 2021, Italy has in fact recorded a demand for 125,350 t of compostable bioplastics out of a total of 220,000 t of plastics processed according to the Italian consulting company Plastic Consult.

This data is the result of a targeted strategy adopted in 1990s that demonstrates how lawmakers can stimulate

process and product innovation throughout the entire life cycle. It also shows how reconciling environmental and economic sustainability is possible.

### *An All-Italian Phenomenon*

“The change began in the early 1990s, when the city of Milan adopted a new approach to waste management by implementing a separate collection model. This was based on the separation between the dry fraction and the organic fraction of urban waste,” explains Armido Marana, CEO of Ecozema (based in Santorso, near Vicenza) and Vice President of Confindustria Vicenza for Sustainability, Circular Economy and Environment. “The measure paved the way for

the ‘Decreto Ronchi’ of 1997, an organic reform which implemented three European directives on waste, hazardous waste and packaging.”

This marked the beginning of a new era of research and development. In 1992, the first compostable shopper made from Novamont’s biopolymer Mater-Bi was launched; in 2012, a Legislative Decree banned traditional HDPE shopping bags. A few years later, the European Commission also adopted this measure. It is therefore evident why the first compostable plastic item was a shopper. “It was the perfect container for taking organic fraction to the composting plants,” continues Armido Marana.

Today in Italy, there are 359 composting plants, of which 65 include an anaerobic digestion section for the production of biogas. “The obligation to separately collect the organic fraction throughout the national territory as from 1 January 2022 did not catch us unprepared. Again, Italy is setting a new standard, because there will be a similar commitment introduced in the rest of the European Union in early 2024,” concludes Armido Marana.

The availability of a highly organized system throughout Italy is the reason that led Italian lawmakers to focus on compostable bioplastics in the implementation of the SUP Directive (SUP: single-use plastics). This should guide the European Commission for the draft of the packaging regulation which is currently in the approval phase.

### *Compostable Cutlery, a Growing Business*

Antonio Munarini (**Title figure**), President of Ecozema, believed in this circularity-oriented project, and in 2005, he



**Fig. 1.** To manufacture disposable cutlery, Ecozema invested in an e-mac injection molding machine. © Ecozema

restructured his company's production, opening up the business of disposable cutlery (**Fig. 1**) and tableware made of compostable biopolymers and plant fibers. Success came later, when Ecozema cutlery echoed in the international press for arriving on Olympic Village tables during the 2012 London Olympics. The factory continued to expand. A couple of years ago Antonio Munarini decided to further increase productivity by investing in

- two new Engel all-electric e-mac 740/280 injection molding machines,
- a 16-drop valve gate family mold for the production of a complete cutlery set with knife and fork (**Fig. 2**),
- another 16-drop valve gate system for a single fork and
- a 24-drop system for the production of an ice cream spoon (**Fig. 3**).

The strong improvement in demand led to the purchase of another injection

molding machine, an Engel e-mac 765/280, which has been up and running since June 2023.

### *Overall Process Efficiency as Decisive Factor*

For Ecozema the e-mac series proved to be a good choice because of its compact design, achieved by a short clamping unit with a very large opening stroke, low power consumption, and high precision due to electric movements, including injection and extraction.

"Thinking about the new production cell, we did not only focus on the efficiency of the injection molding machine. Our goal was to find the best possible balance between energy consumption and machine output for the product to be manufactured, keeping in mind that the decisive factor is the overall efficiency of the process," explains Antonio Munarini. Therefore, some adaptations were made in the order of the latest e-mac.

"The plasticizing unit was optimized by implementing a 50 mm diameter screw, slightly larger than the 45 mm screws installed on other machines. In the injection molding of Novamont's fourth Generation Mater-Bi, this solution allowed us to reduce the cycle time and increase the plasticizing capacity without material degradation, despite the longer residence time in the cylinder. This way, we are able to produce cutlery that is stiffer and therefore safer for consumers," explains Antonio Munarini.

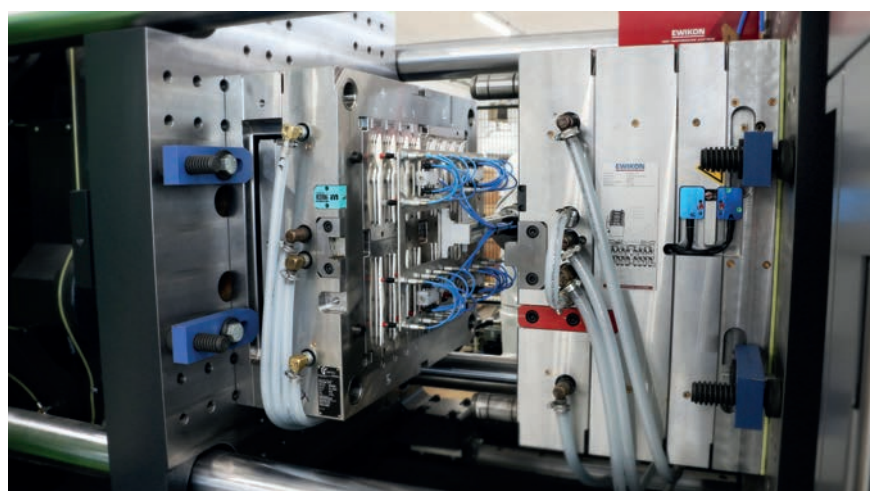
"iQ melt control also improved plasticizing performance," explains Matteo

Terragni, Managing Director of Engel Italia. "The intelligent assistant automatically determines the optimum plasticizing time for each application. Instead of plasticizing at the maximum possible speed, the software takes advantage of the part's in-mold cooling time. The machine operator only has to enter the screw type and the material to be processed." Benefits are considerable. iQ melt control provides consistently high-quality melt and longer service life for the screw, improved part quality and greater efficiency.

### *Systematic Approach to Smart Injection Molding*

Another adaptation was made by upgrading the software. In addition to iQ melt control, iQ weight control and iQ clamp control have also been installed. "We aimed better quality, so we decided to make the injection molding process smarter," emphasizes Antonio Munarini. The abbreviation iQ stands for "intelligent quality", meaning the integration of expert knowledge into the injection molding machine control. The aim is to increase the productivity and reproducibility and to reduce rejects by adaptation of parameters throughout the running process.


"iQ weight control can automatically adjust variations in melt viscosity, one of the major challenges »



**Fig. 2.** The 16-cavity family mold for the production of knives and forks on the Engel e-mac. Removal and packaging of the cutlery are fully automated. © Ewikon

## Info

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## Text

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**Fig. 3.** Particular of the 24-cavity mold for the production of ice cream spoons. © Ewikon



**Fig. 4.** Six fully automated production lines turn out millions of parts every year. Automation also includes digital process monitoring. © Ecozema

to molders of recycled plastics. Bioplastics show a similar behavior. We therefore thought that software could help us to approach the regulation of the process parameters in a more scientific way," explains Antonio Munarini. iQ weight control compares the injection pressure curve of each cycle with a defined reference curve. In case of deviations, for example due to external influences, the software reacts directly in the current cycle. As a result, the accuracy of the injection molding process increases and the weight of the parts remains constant.

"The growing attention on energy saving led Ecozema also to install iQ clamp control," explains Matteo Terragni. "The intelligent assistant automatically reduces the clamping force to the minimum required while maintaining optimum part quality. This means that the drive energy needed for clamping force build-up can be reduced. This saves energy and cycle time. Moreover, using the software protects the mold and the injection molding machine."

### **Competitive Mass Production thanks to Automation**

The reason for putting much effort in plant construction and for the choice of software solutions is not difficult to understand. "Cost-efficient mass production and at the same time maintaining high hygienic standards are essential factors for being competitive in single-use cutlery production, so it is important to have a high level of automation with minimal human involve-

ment and optimal process control," explains Antonio Munarini.

The cell for the simultaneous production of fork and knife is the most complex of the three in terms of automation. In addition to the automated removal of the parts by means of a handling system, the complete packaging is integrated into the process. After the forks and knives have been placed on a conveyor belt, they are picked up in pairs under camera control, automatically placed on a paper napkin and finally packed and sealed.

### **Family Mold for Fork and Knife**

Another complex component of the production cell is the family mold (**Fig. 2**), considering the substantial different in weight and shape of the two parts. It is a 16-cavities mold, designed and manufactured by Italian toolmaker Uniform (Marostica, near Vicenza). For the development, Uniform involved the German hot runner supplier Ewikon.

To optimize the process, the hot runner has been designed to ensure high reliability, material savings and a consistent cavity filling, to minimize scraps, production stops or delays in the following steps of the automated process. The cavity balancing, with the forks and knives divided in groups of eight parts, was achieved with a rheological study and different melt diameters to compensate the differences, with a single actuator plate for the valve pins. This solution was the most compact and efficient from the tool design point of view.

A similar approach was used for the 16-cavities fork mold, in this case with

naturally balanced hot runner system. However, the design for the 24-cavities ice cream spoon tool (**Fig. 3**) substantially changed during the development process. "Extensive tests in cooperation with Ecozema and Novamont highlighted the excellent performances of Ewikon's direct side gating HPS III-MH nozzle, as alternative to traditional hot tip solutions," comments Riccardo Passuello, Uniform Sales Manager. "The tool is smaller, runs with a faster cycle time and reduced operational costs, proving to be the ideal technical solution and also the most cost-effective one."

Needle valve gate systems installed on the other tools are using HPS III-NV nozzles, with direct heating and melt channel with 6 mm diameter. All needles are installed on a synchronous plate, equipped with position sensors in the clamping plate and moved by pneumatic drives installed in the clamping plate. To simplify maintenance, the tool has been supplied with exchangeable gate inserts, wear resistant and easy to replace. Thanks to their contour, they can be individually replaced, without any actions on the cavity plate.

### **High Efficiency Production Lines**

Today, the three fully automated Engel lines continuously produce 150 million parts per year. In addition, three long-serving production cells also based on Engel injection molding machines complete the cutlery production (**Fig. 4**). An excellent result achieved thanks to a technological cooperation that allows to attain the best possible solution. ■